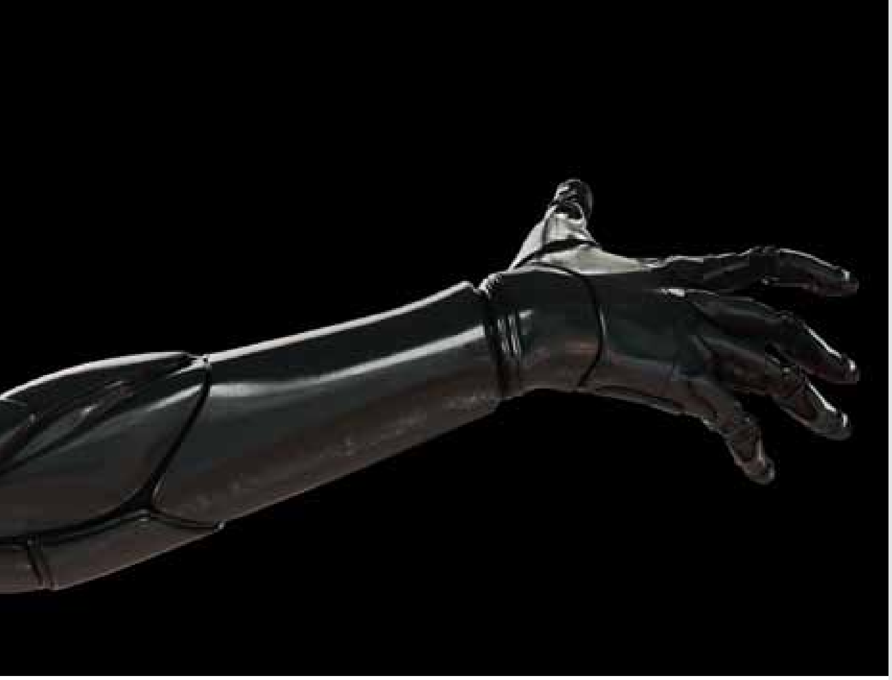

NATIONAL INSTITUTE OF AEROSPACE

Jefferson Lab

Boron Nitride Nanotube Synthesis

A new method for developing boron nitride nanotubes with superior morphology

NASA Langley, Jefferson Lab, and the National Institute of Aerospace have jointly developed a new method for manufacturing boron nitride nanotubes (BNNTs). BNNTs are a direct analog of carbon nanotubes, with superior properties for many applications. They are as strong as carbon nanotubes (within a few percentage points) and are good thermal conductors. However, they have a much higher service temperature, are highly electroactive, shield neutron radiation, have a more active surface chemistry, are non-cytotoxic (in tests on human cells), and are naturally white (can be dyed). BNNTs produced by this method have far superior morphology than those previously available. The new tubes have a nearly perfect crystalline structure (Figure 1) with one wall to just a few, and are extremely long. Because of the length of the tubes and the white color, the raw material produced by the new method has the physical appearance of cotton (Figure 2).

Benefits

- One-to-few-walled tubes with high crystallinity
- Very long, high-aspect ratio tubes
- High scale-up potential
- No toxic catalysts (only boron and nitrogen are used as reactants)
- Usable with standard industrial cutting/welding lasers
- High service temperature (over 800°C)
- Highly electroactive (due to the B-N polar bond)
- Neutron radiation shielding (due to their boron content)

partnership opportunity

The Technology Gateway

The Technology

The new synthesis method, called the pressurized vapor/condenser (PVC) technique, is described in "Very long single- and few-walled boron nitride nanotubes via the pressurized vapor/condenser method" (M. W. Smith et al., Nanotechnology, 20, 505604, 2009). The technique involves high-power laser heating of a boron-containing target under high-pressure nitrogen. A proof-of-concept pilot facility has been constructed to demonstrate the method. Typical rates for the synthesis of raw material are between 20 and 100 mg/hour. The purity of the raw material is estimated to be between 25% and 40% by mass, the primary contaminants being particles of boron nitride and boron. No catalysts are used in the synthesis process. The only reactants are boron and nitrogen, which are both nontoxic. The long BNNTs in PVC-grown raw material can be spun directly into yarns or threads (Figure 3), although mechanically strong yarns will require purification prior to processing.

Applications

- High strength-to-weight polymer composites
- High strength fibers
- Toughened, fracture-resistant ceramics
- High performance textiles
- Piezoelectric devices
- Radiation-resistant and radiation-shielding materials
- Neutron radiation detectors
- Tissue engineering and nano-medicine materials
- UV shielding for photovoltaics and other devices
- High efficiency desalination membranes
- Electronic, photonic devices and sensors

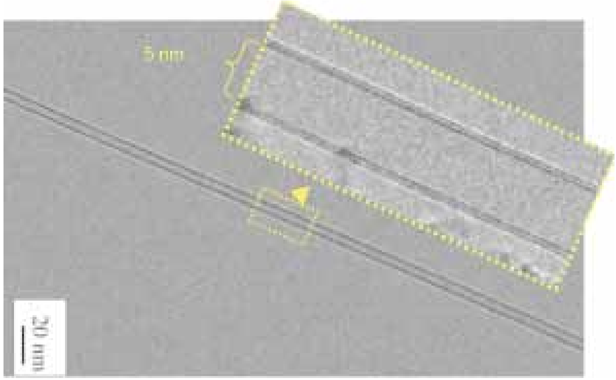

Figure 1. TEM micrograph of a double wall BNNT grown by PVC method.

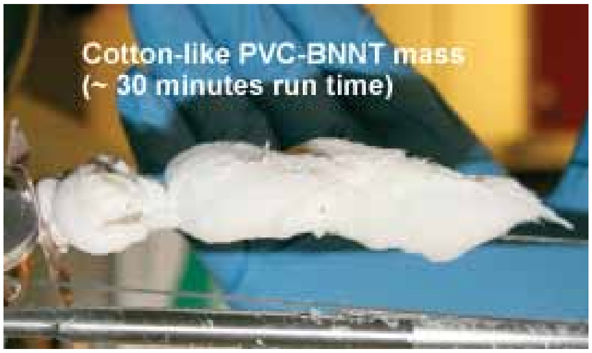

Figure 2. Cotton-like PVC-grown raw material.

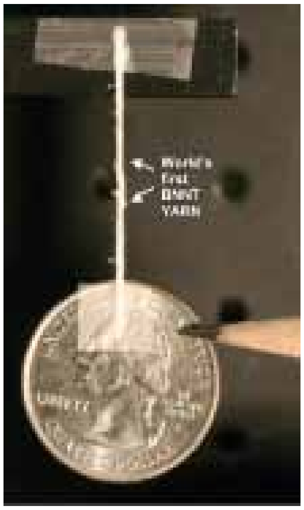

Figure 3. World's first BNNT yarn, spun directly from unprocessed PVC-grown raw material.

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering, please contact:

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LAR-17535-1, LAR-17668-1, LAR-17780-1,
LAR-17991-1, and JLab 1265.

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